



Engineering Fire Safety for Standards and Codes Development

Richard W. Bukowski, P.E., FSFPE

Senior Engineer

NIST Building and Fire Research Laboratory

Gaithersburg, Maryland 20899 USA





US Building Regulatory System

- State and local regulation based on model codes (codes become regulations when adopted into law) adapted for local conditions and practices
 - Model codes developed by non-profit membership groups (NFPA and ICC)
 - No formal role for the Federal government
- Regulations specify what is required under what conditions
 - Performance codes available but the system is still largely prescriptive
- Referenced standards contain technical details of how



Primary Engineering Standards

Design, Installation, Operation, Maintenance, Testing

- ⊗ **Structural safety** (normal and expected conditions of use)
 - ⊠ ASCE 7 Design loads (dead, live, wind, snow, seismic, ...) {GBJ9}
 - ⊠ ACI 318 Concrete {GBJ10} & AISC 7 Steel (response to loads)
 - ⊠ ASCE/SFPE 29 Structural response to fire (ASTM E119/ISO 834 equivalence)

- ⊗ **Fire Safety** (design fire scenarios, understand the consequences in extreme events)
 - ⊠ NFPA 70 Electrical safety (prevention)
 - ⊠ NFPA 72 Fire Alarm Systems
 - ⊠ NFPA 13 Fire Sprinkler Systems
 - ⊠ NFPA 90B Smoke Control
 - ⊠ Egress design and passive methods are part of the building code {GBJ16}

The primary objectives of US building regulations are to promote the public health, safety, and welfare with structural and fire safety the key technological challenges



Who does the Fire Safety Design?

⊕ Prescriptive design

- ⊠ Specified by licensed design professional, usually architect
- ⊠ Based on prescribed requirements in regulations and referenced standards
- ⊠ It complies by being there

⊕ Performance design

- ⊠ Design by qualified, licensed professional, usually engineer
- ⊠ Based on agreed performance objectives and engineering analysis
- ⊠ Verified by peer review



Performance Design in the US

- Long been accepted as an equivalent means to meet the intent of the regulation
 - Hard to measure/agree on equivalence or intent
- Common for unique or constrained projects
 - Unique Las Vegas hotels (35 story pyramid, 11 story building on top of a 300 m stand, ...)
 - Constrained shopping malls, airports and convention centers (large, open spaces; issues: large fire areas and travel distances)
 - Very similar in China



National Stadium and the Water Cube



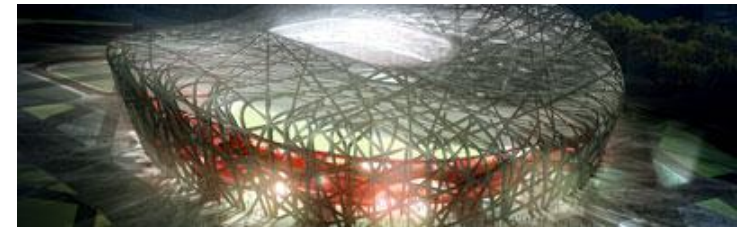
CCTV Hq
Cultural Ctr



CCTV Hotel



Beijing Airport
Terminal 3





Standards of Practice for Fire Safety Engineering

- ❖ *SFPE Handbook of Fire Protection Engineering*
- ❖ *SFPE Engineering Guide to Performance-based Fire Protection Analysis and Design of Buildings*
- ❖ Fire Engineering Guidelines
 - ❖ BSI DD240
 - ❖ Australia, New Zealand, Japan
 - ❖ Multinational collaboration (US, Canada, Australia & New Zealand)
- ❖ ISO TC92 SC4 technical reports and standards



Global Trends in Fire Safety Standards

- ✿ Strong influence of ISO (TC92) in the development of Fire Safety Engineering Practice
 - ✦ TC92 Framework (N911)
- ✿ Standards developers who meet the WTO Guidelines for International Standards
 - ✦ ISO, NFPA, UL
- ✿ Increasing role of Professional Societies
 - ✦ Society of Fire Protection Engineers (US++)
 - ✦ Institute of Fire Engineers (EU++)
 - ✦ Society of Fire Safety (AU)
 - ✦ China Fire Protection Association (CN)



TC92 Framework

- ⊕ Level 1 assess all aspects of performance
 - (A) Standard Guides on Goals and Objectives
 - (B) Test methods to produce data for assessment of whole building performance
 - (C) Requirements for models and engineering methods of whole building performance
 - (D) Terminology or Maintenance standards
- ⊕ Level 2 assess specific aspects of performance
 - (A) Specific performance metrics (combustion, active or passive system performance, tenability, ...)
 - (B) Engineering methods (fire dynamics, structural response to fire, human behavior)
- ⊕ Level 3 Operational standards
 - (A) Computer models and calculation methods
 - (B) Test methods (classification)



Closing Thoughts

- ❖ The world is moving toward performance based methods for building regulation
 - ❖ Basis for performance regulations is well established
 - ❖ More work needed in performance standards development
- ❖ Top level goals and objectives, performance levels, and metrics are common (some cultural variations)
 - ❖ Preservation of historical and cultural resources
 - ❖ Property protection
- ❖ We can all benefit from cooperation to fill remaining gaps (FORUM, CIB, IRCC)
 - ❖ Example: CIB W14 Structural Fire Resistance Prediction